Coronal Jets

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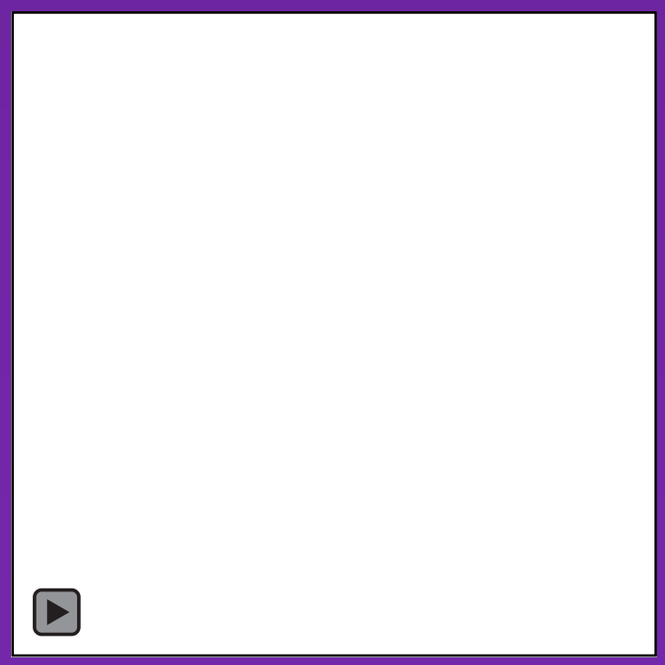
Introduction

- Coronal jets are well seen in X-rays and in EUV (e.g., Shibata et al. 1992, Shimojo et al. 1994, Cirtain et al. 2007, Nisticò et al. 2009, Raouafi et al. 2016).
- Often have a “jet bright point’’ on one side of the jet’s base.
- Seen in coronal holes, quiet Sun, and active regions.
- AR jets are similar in appearance to non-AR jets; AR jets are longer and more energetic.

Cirtain et al. (2007)



Sterling et al. (2017)

Today's Discussion:

- AR jets are basically the same as non-AR jets; they all fit the "minifilament eruption" magnetic geometry.
- But, one difference is that frequently a cool minifilmament is not apparent in (violent) AR jets.

- Why not?? (Possible answers provided.)

- Bonus: What causes minifilament eruptions?

Coronal Hole Jets

Coronal Hole Jets: “Minifilament eruptions”

XRT

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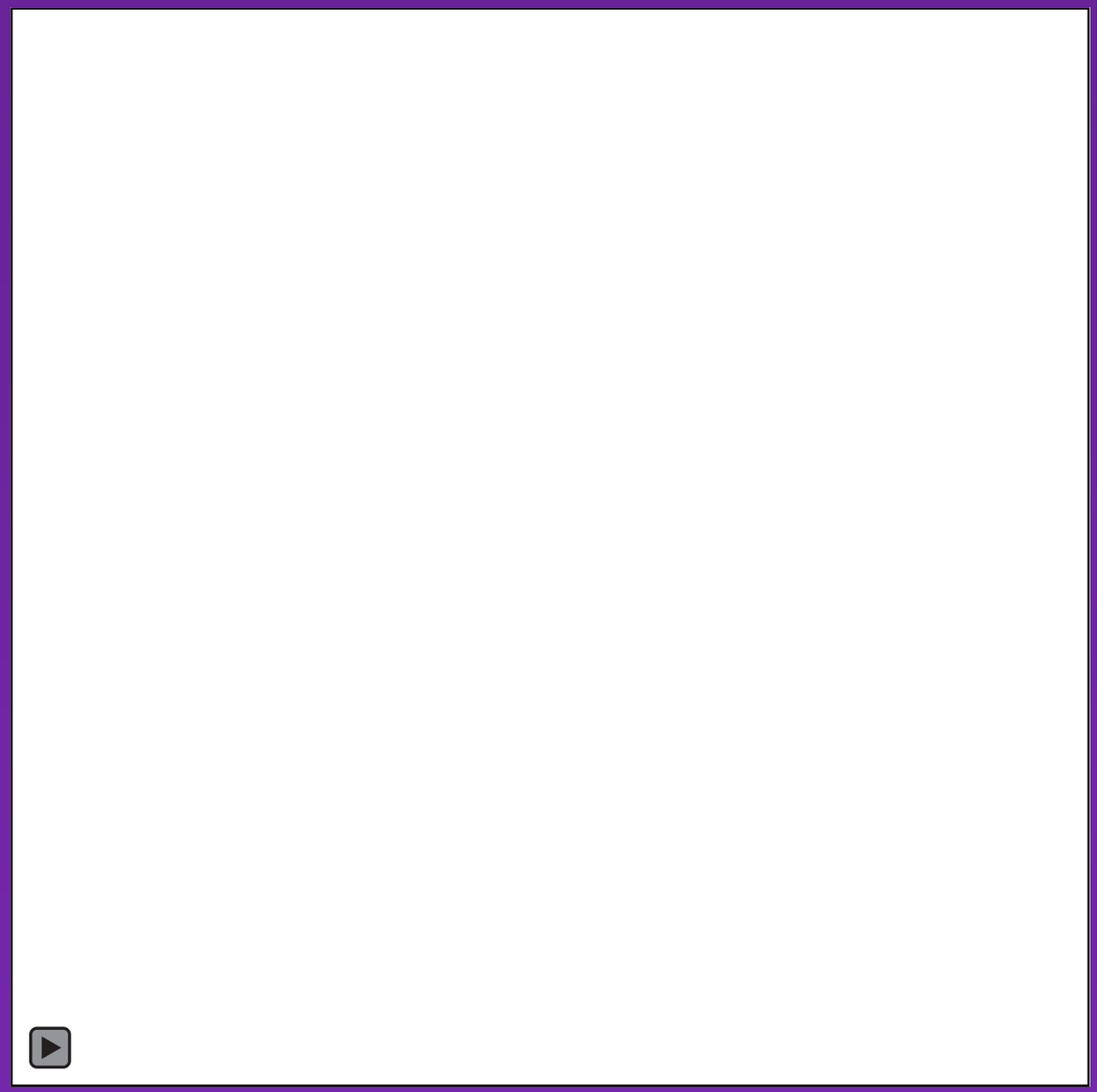

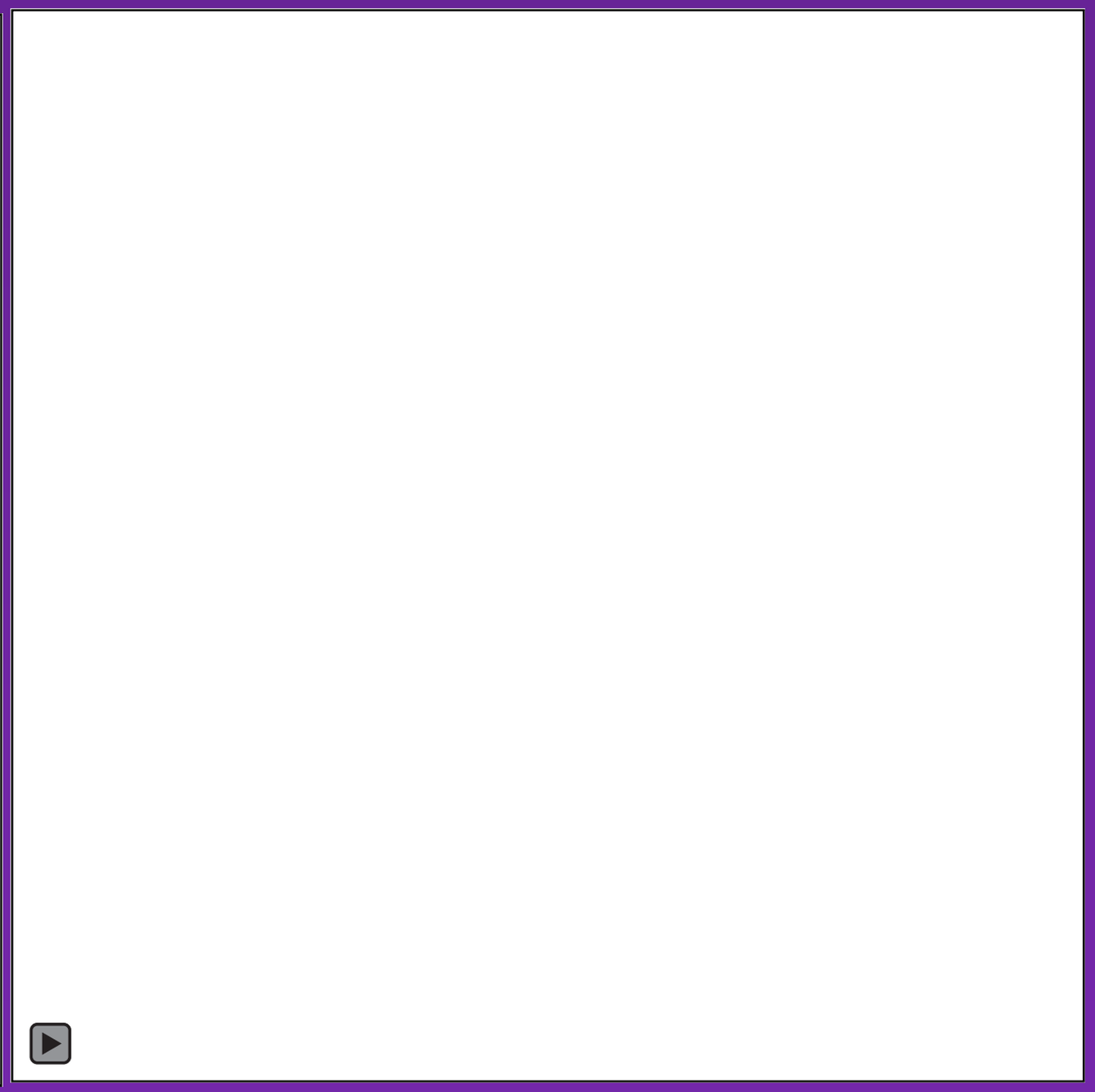

Sterling, Moore, Falconer, & Adams (Nature, 2015): 20 Polar CH jets.

(Sterling et al. Event 18

XRT

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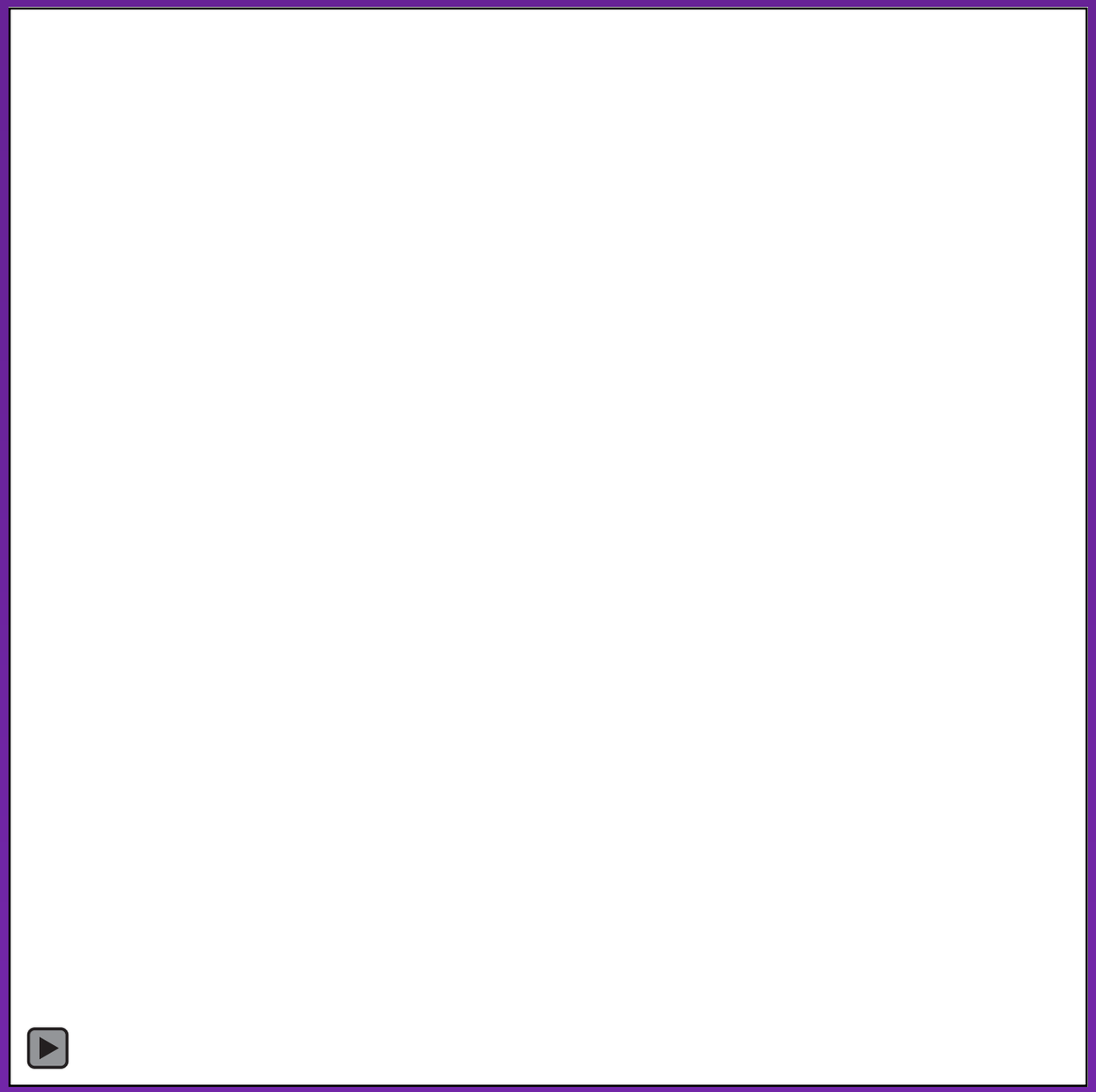

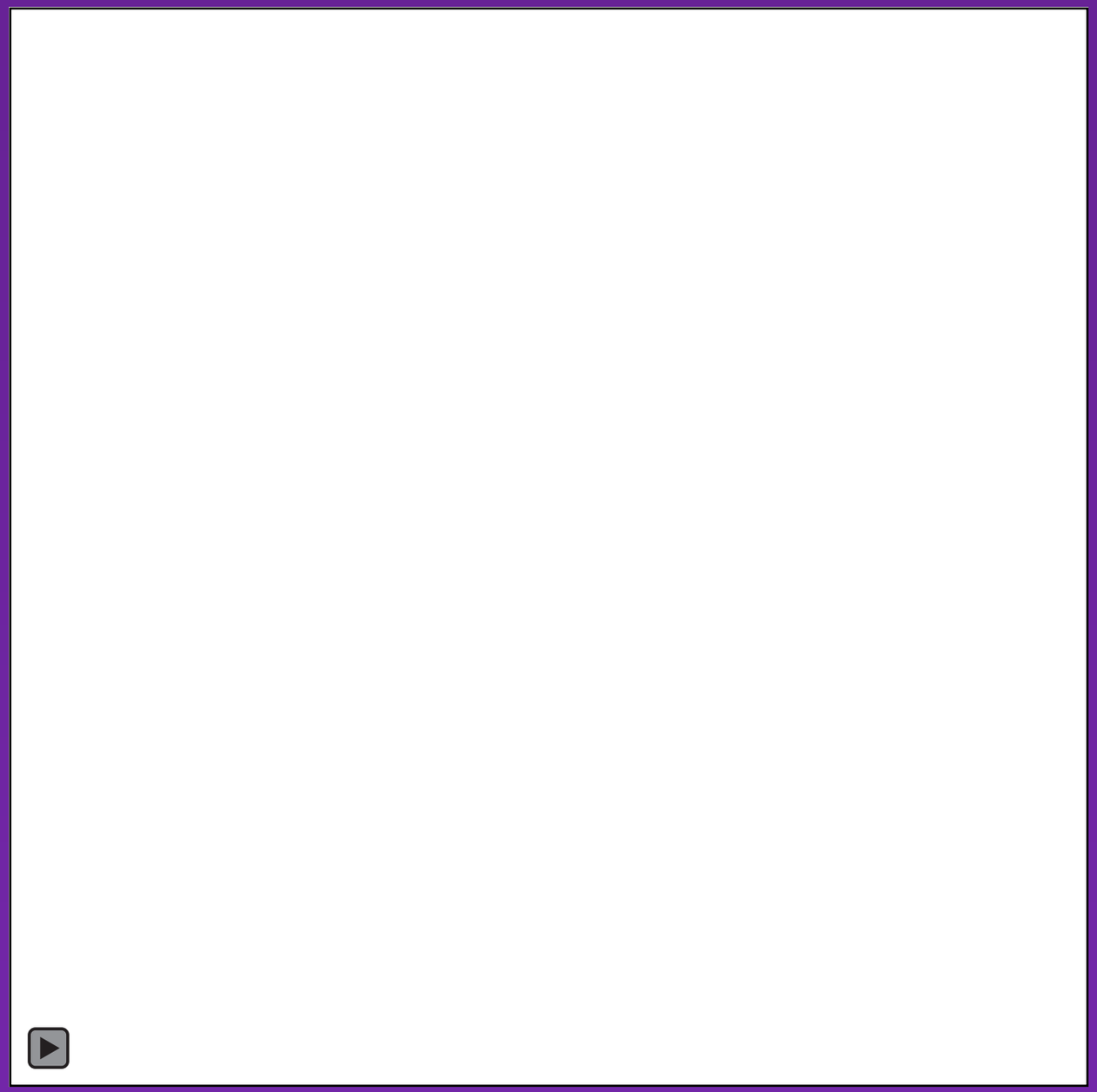

(Sterling et al. Event 3)

“Normal” Filament Eruption (TRACE)

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XRT

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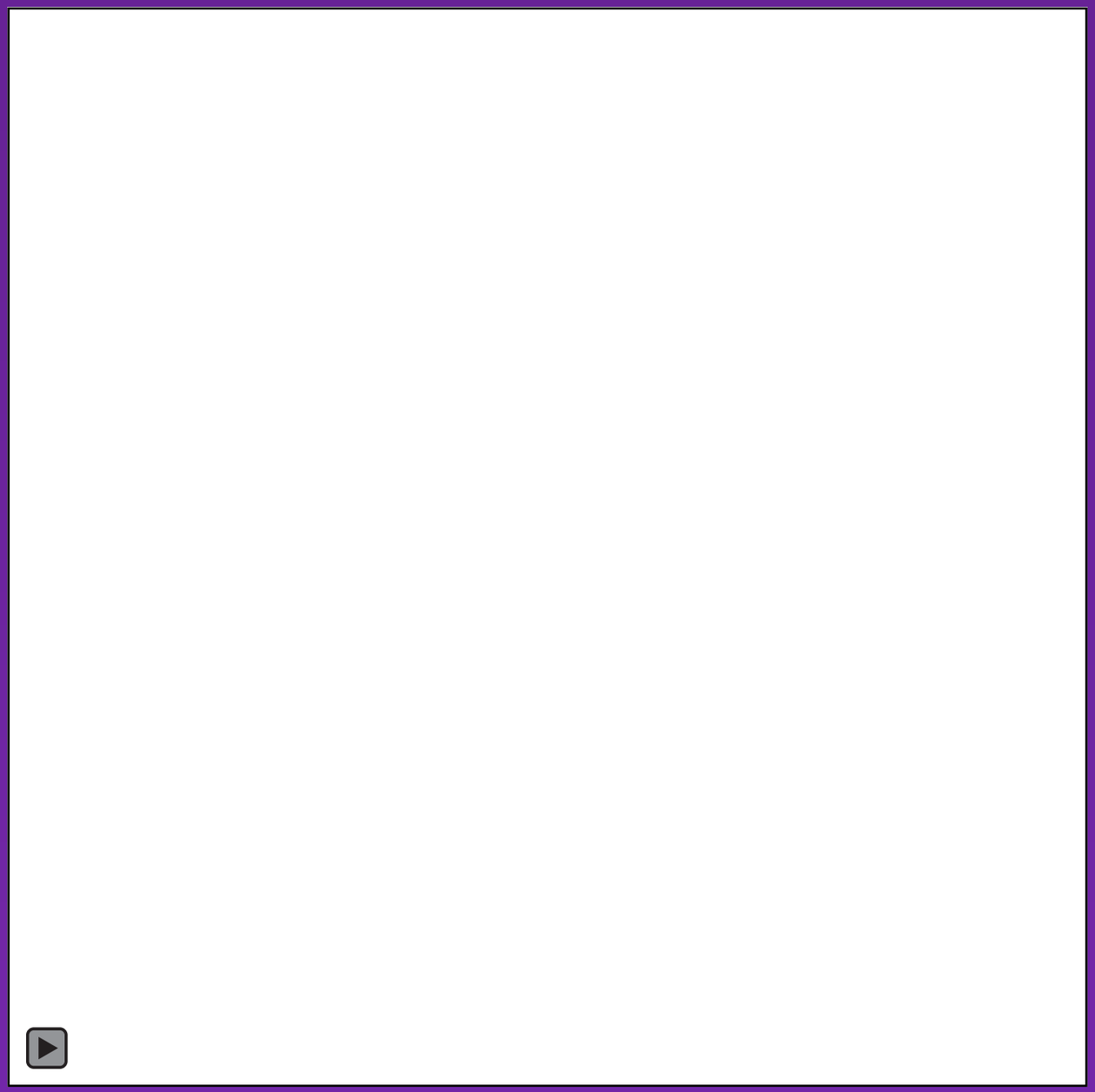

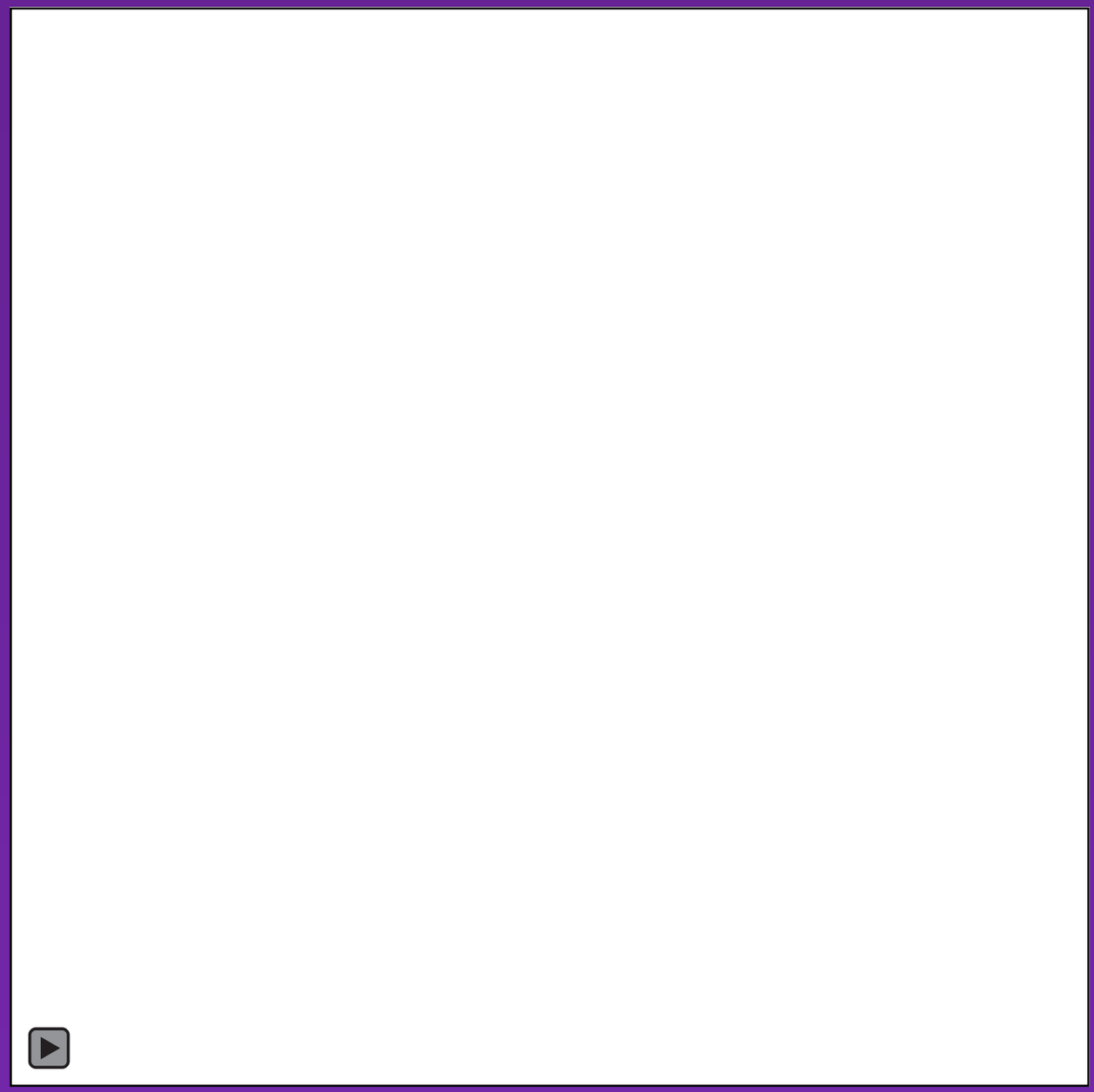

(Sterling et al. Event 1)

XRT

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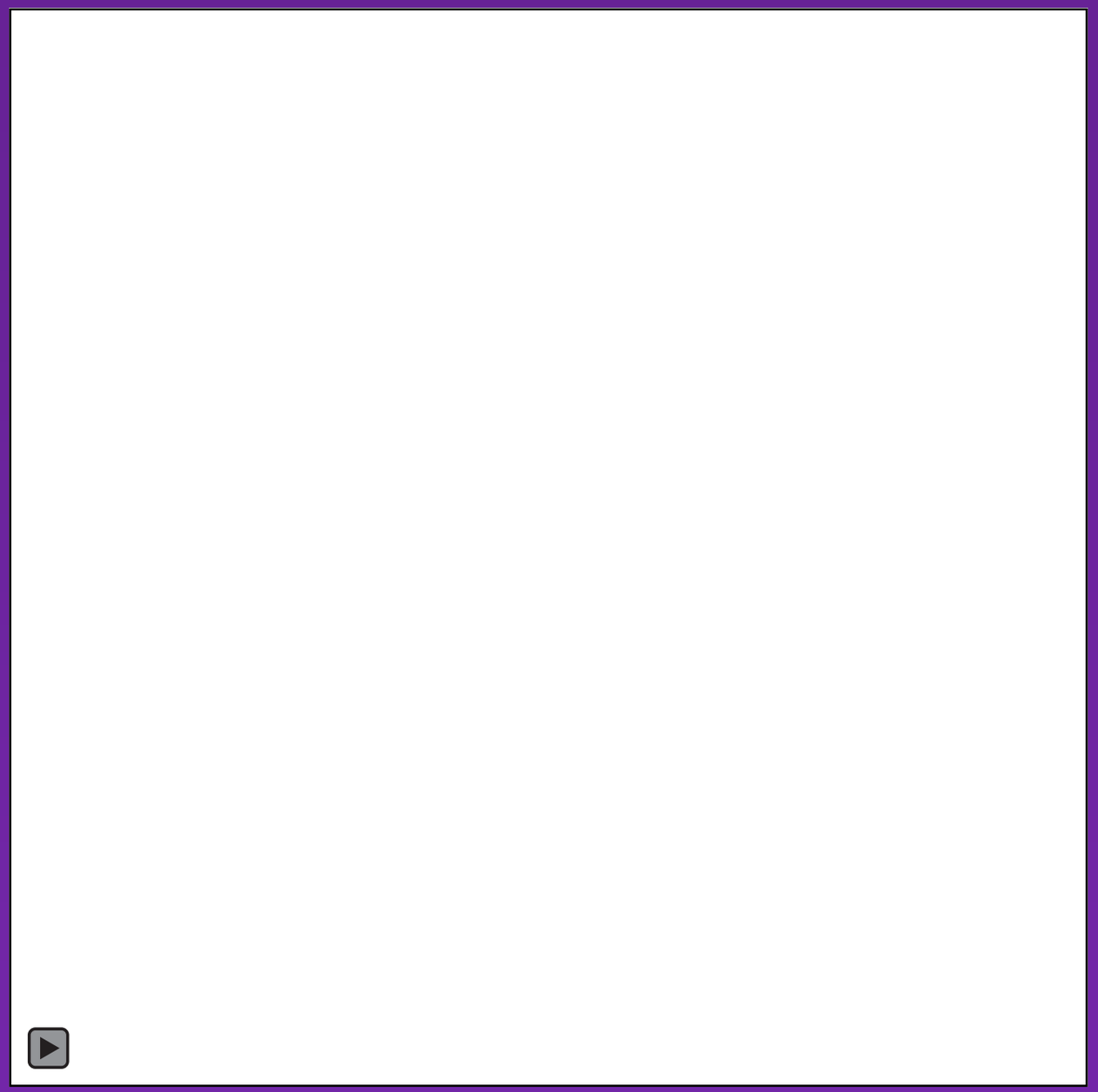

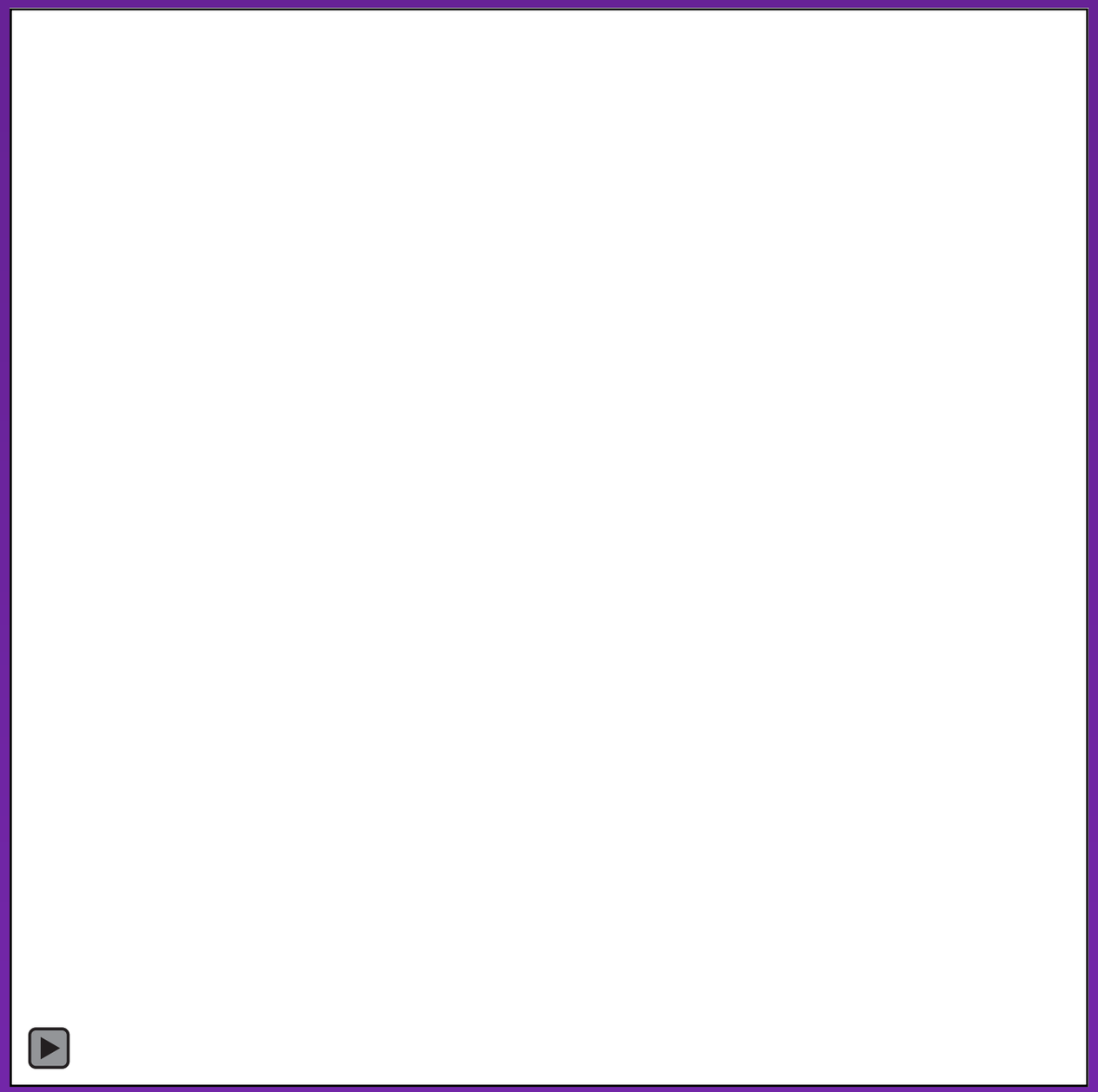

(Sterling et al. Event 2)

XRT

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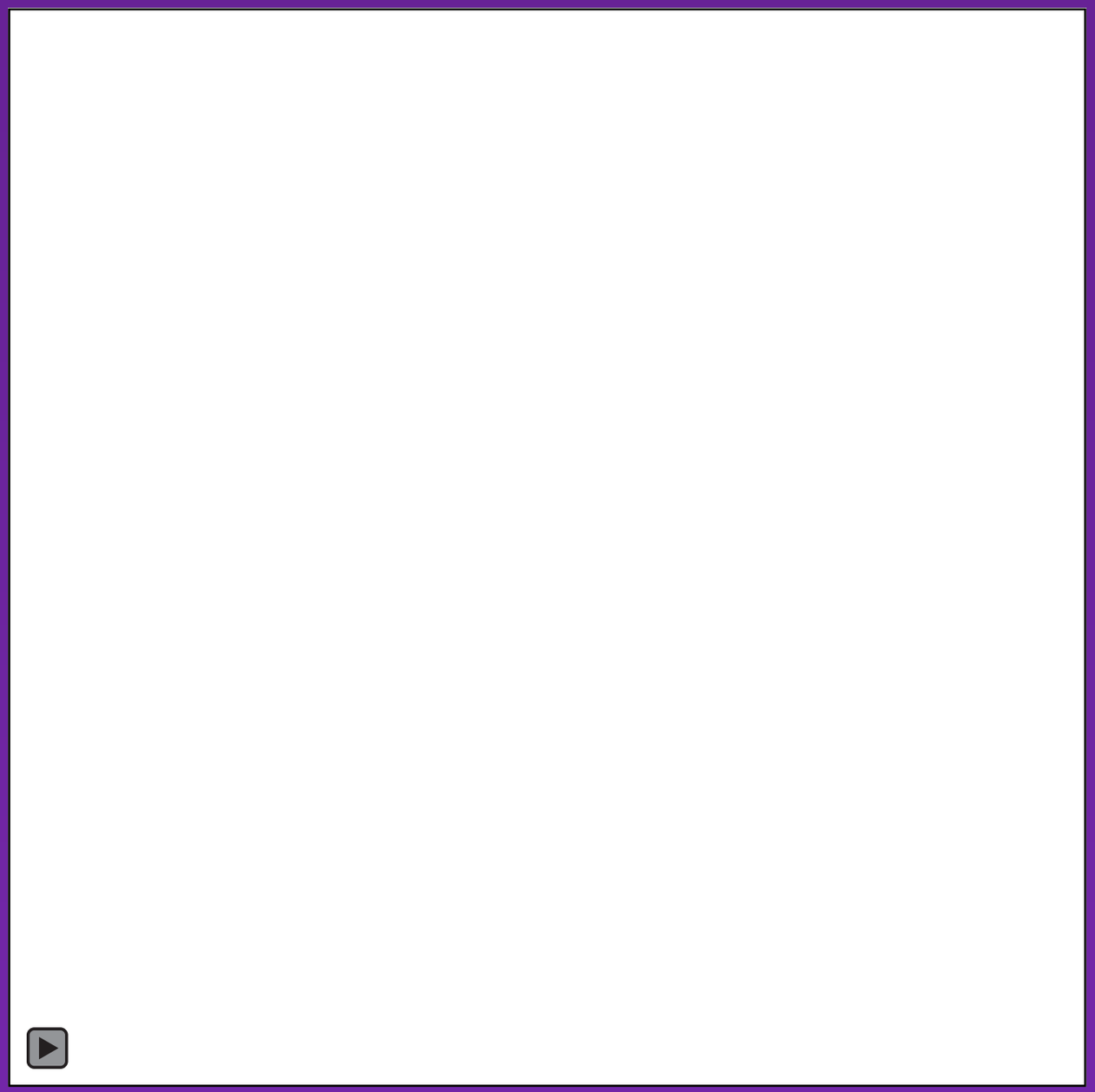
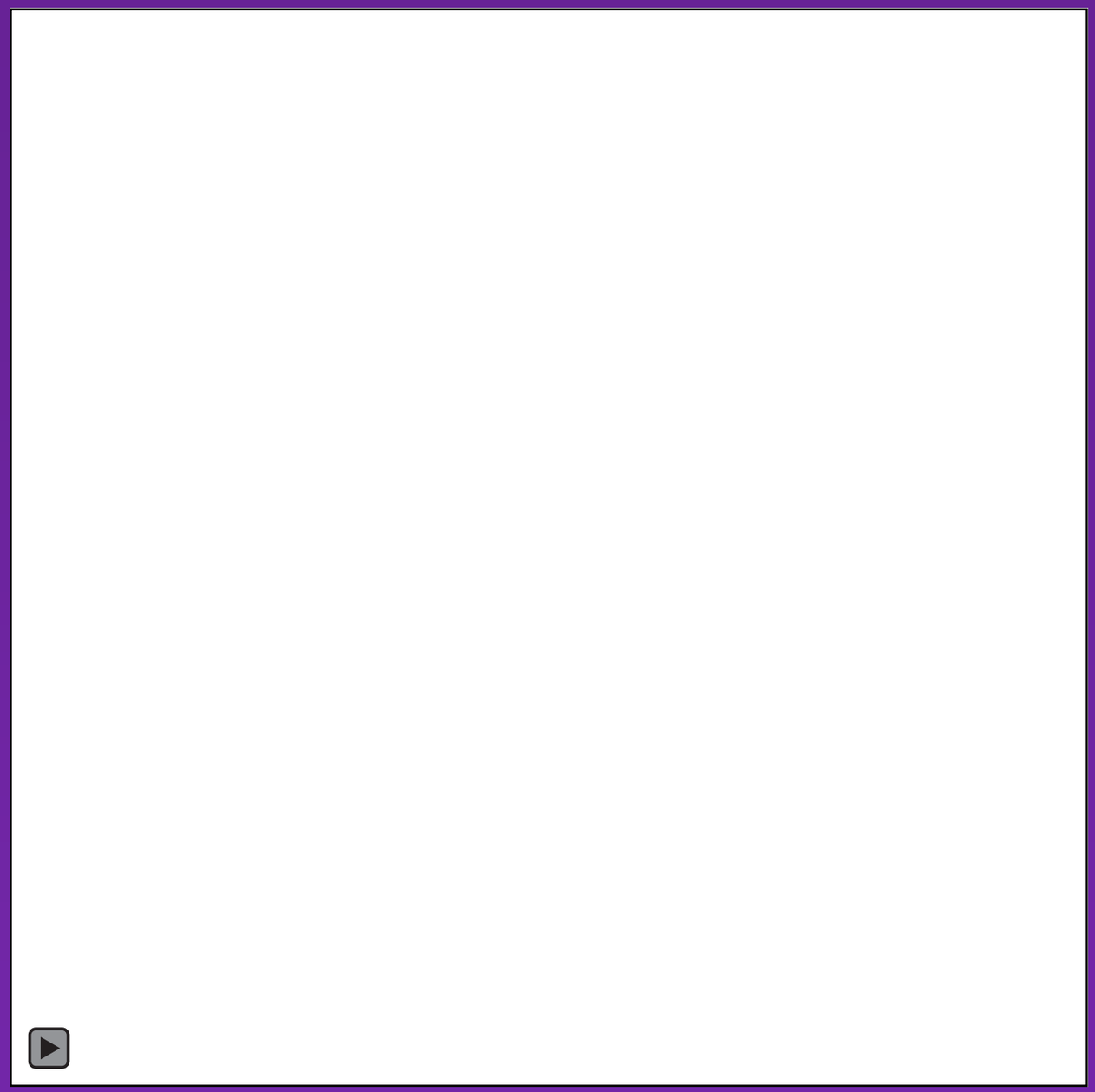
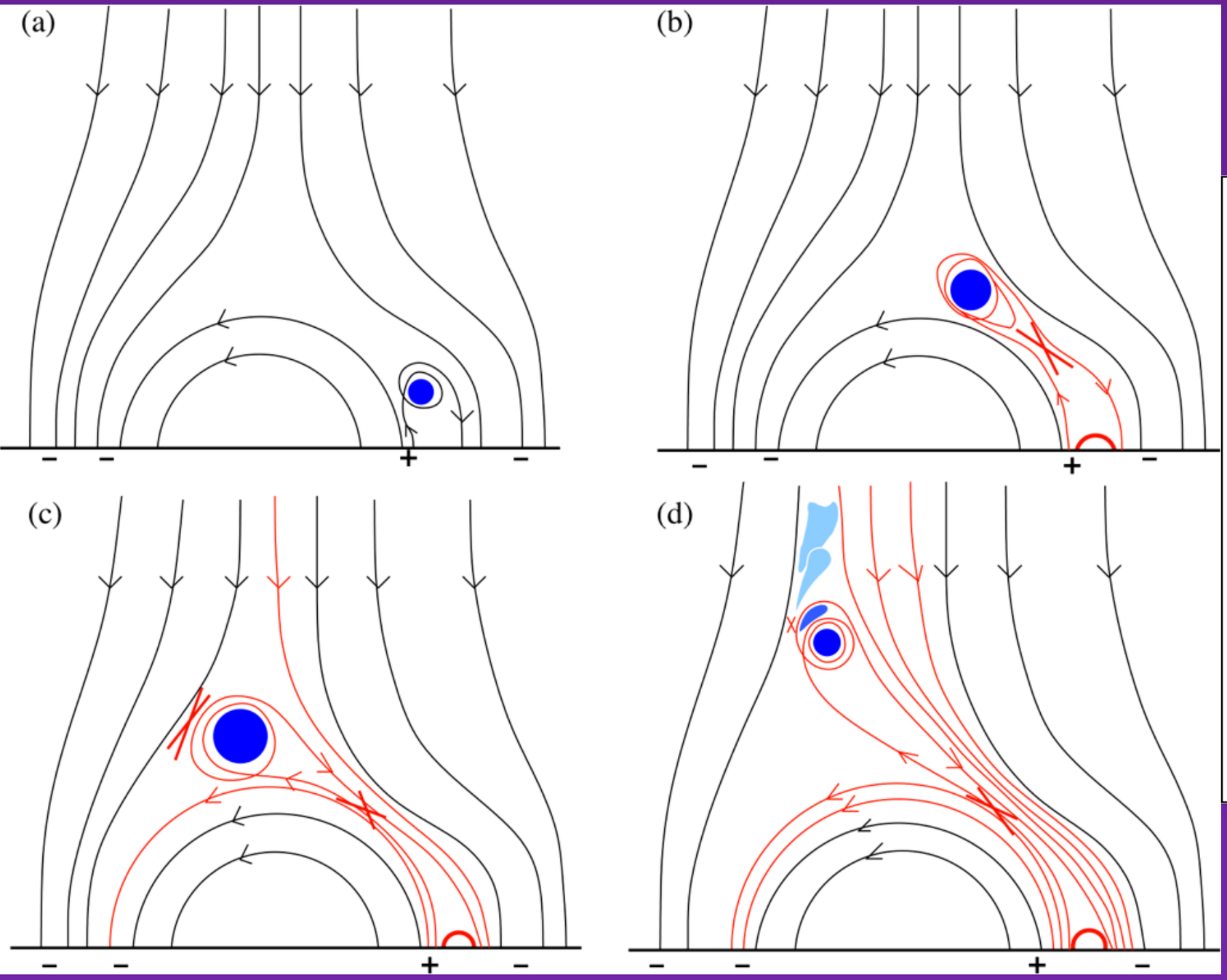




(Sterling et al. Event 8)



Sterling et al. (2015, 2016, 2017): “minifilament” eruptions.

Recently modeled by Wyper, Antiochos, & Devore (Nature, 2017)

Quite Sun Jets

Quiet Sun Jets — Similar to CH jets

AIA 171

AIA 94

(Panesar et al. 2016, ApJL; 10 quiet Sun jets)

Active Region Jets

(Sterling, Moore, Falconer, Panesar, Akiyama, Yashiro, & Gopalswamy ApJ, 2016)

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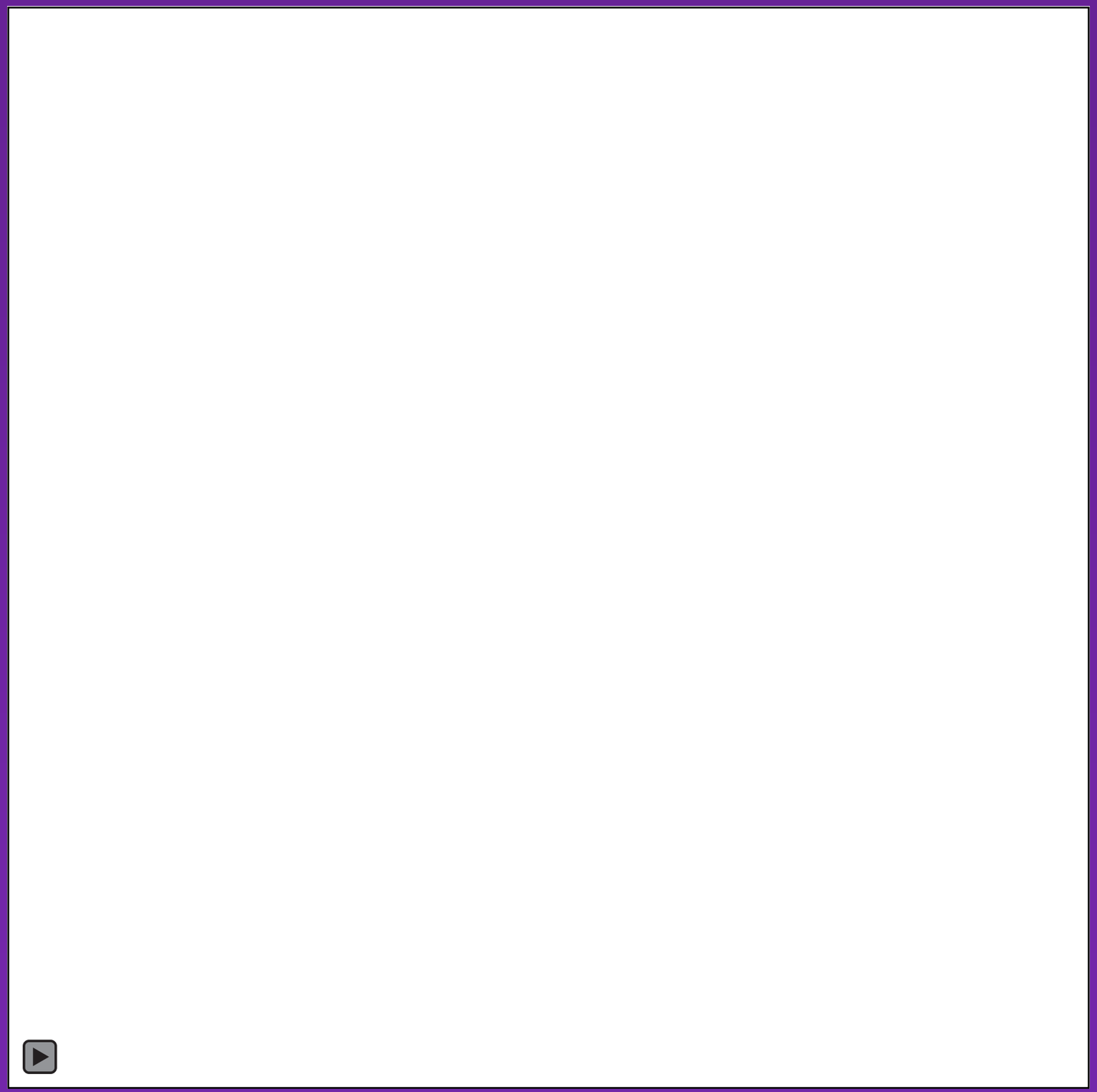
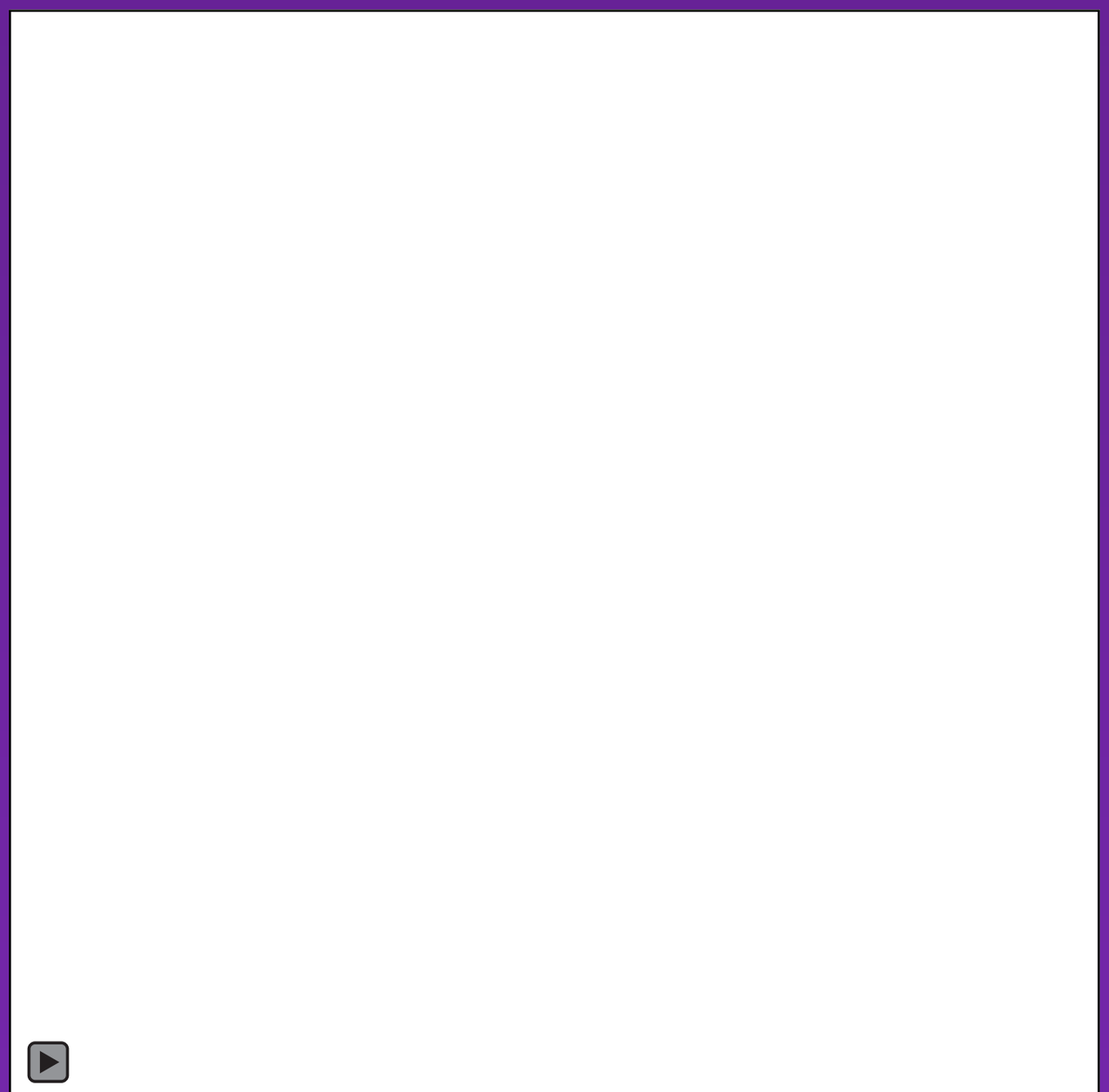
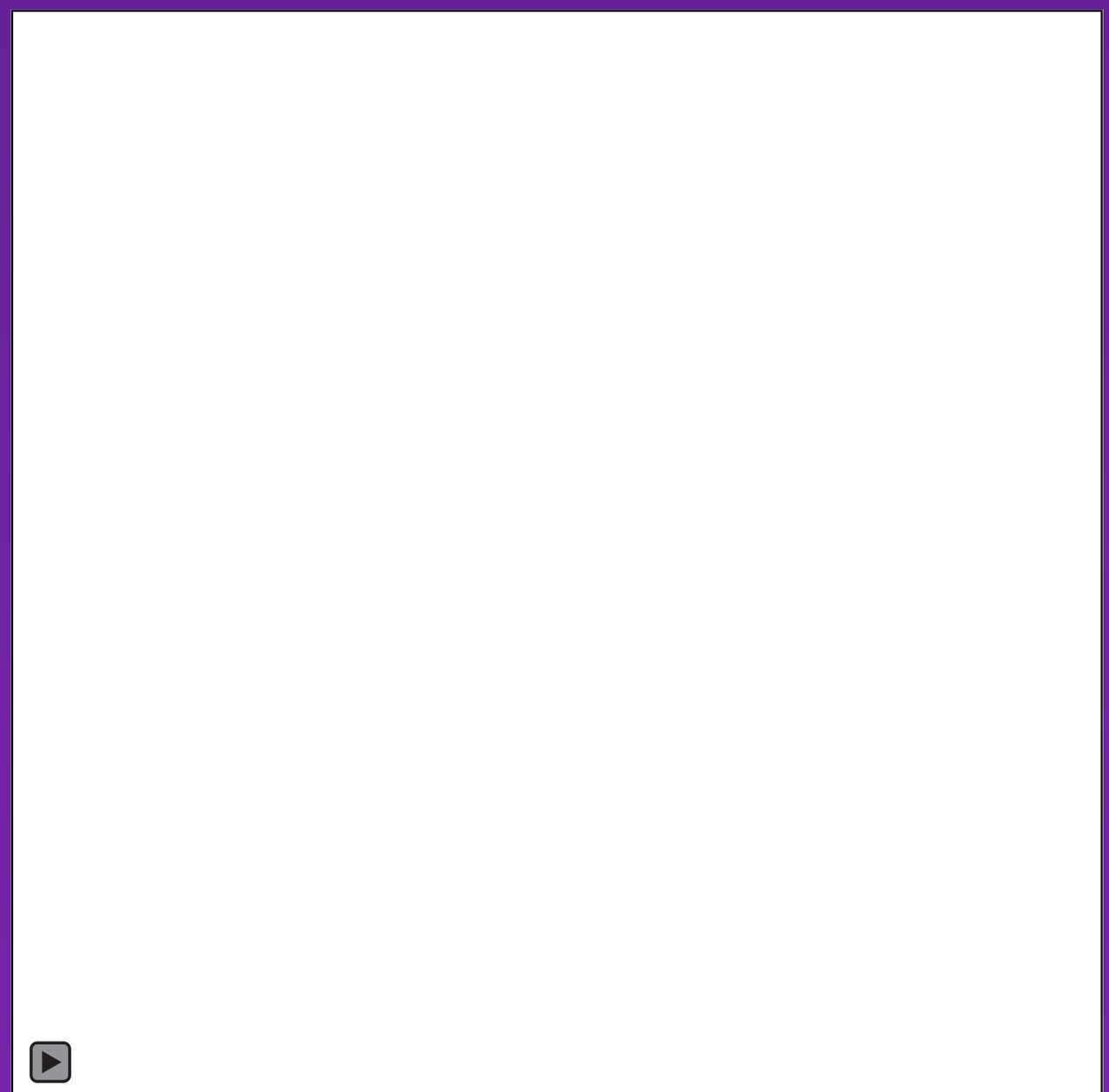
AIA 171



Sterling et al. (2016, ApJ)



AIA 304



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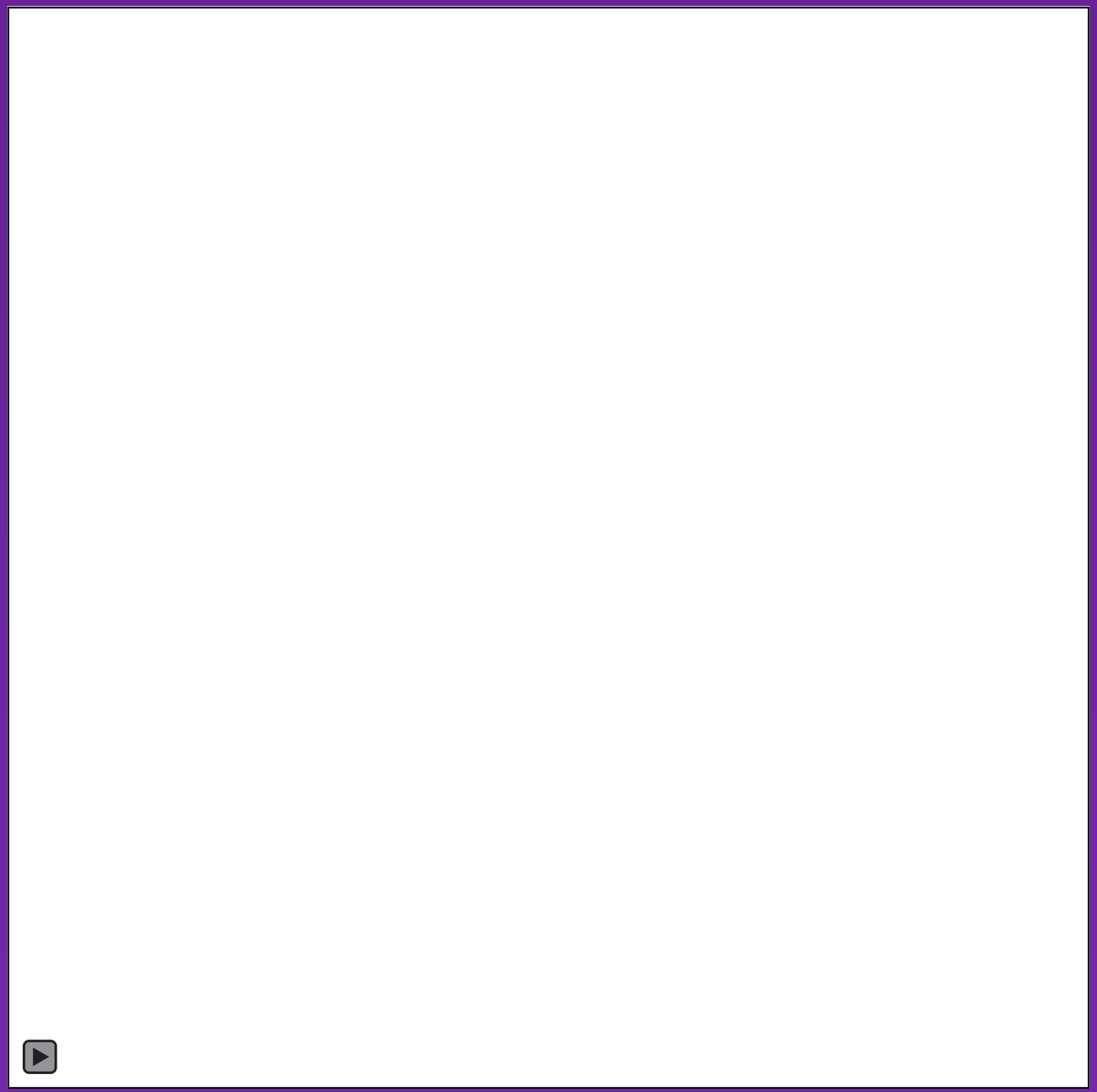
AIA 171



Sterling et al. (2016, ApJ)

Active Region Jets: Sterling et al. (2016) Results:

- Some AR jets show clear minifilaments; they are slowly developing, less “violent”; surge-like, with weak X-ray signature.
- Other jets show little/no minifilaments; rapidly developing, more violent. Have strong X-ray signature.

Active Region “Violent” Jets

(Sterling, Moore, Falconer, Panesar, & Martinez 2017, ApJ)

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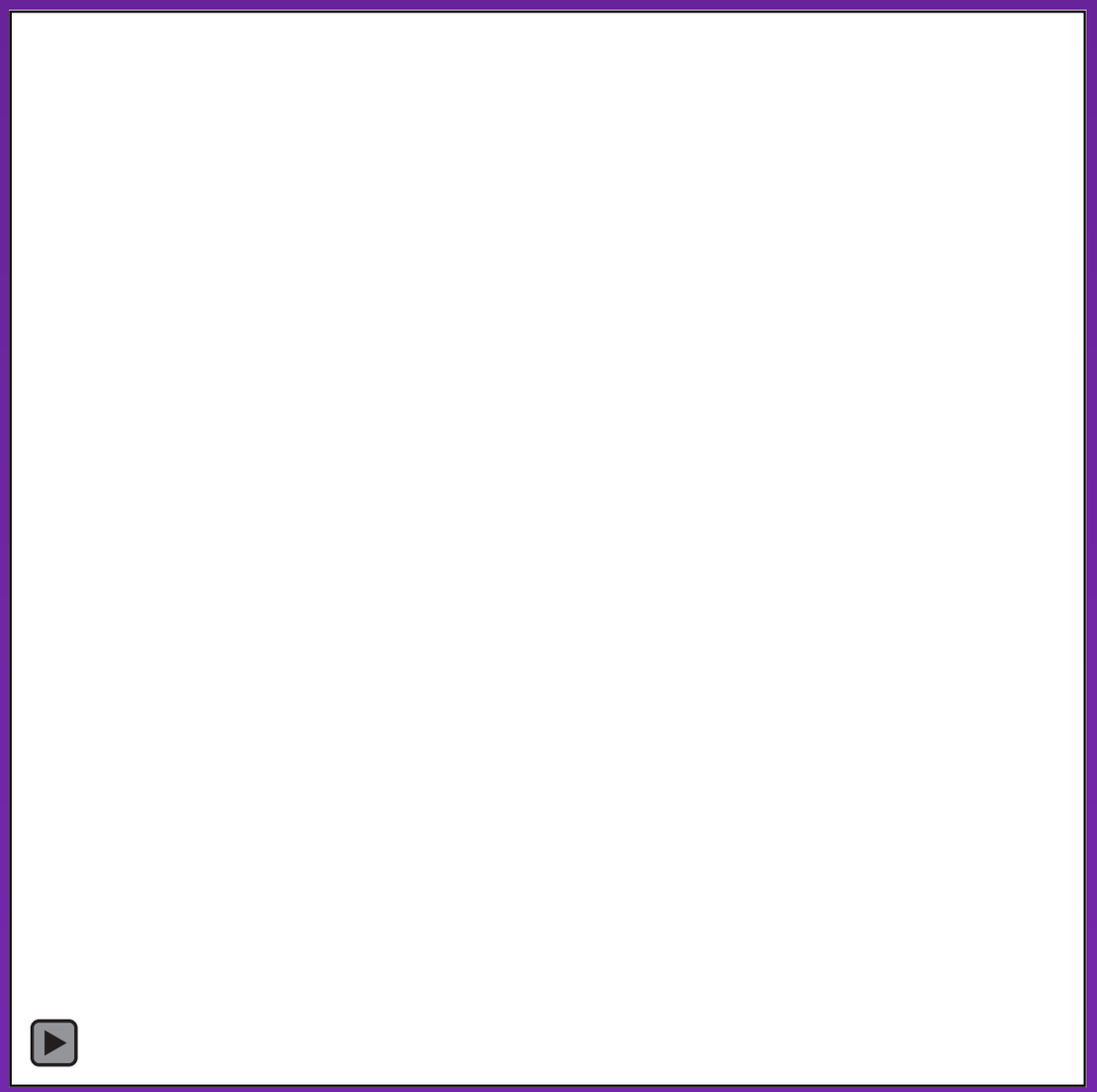
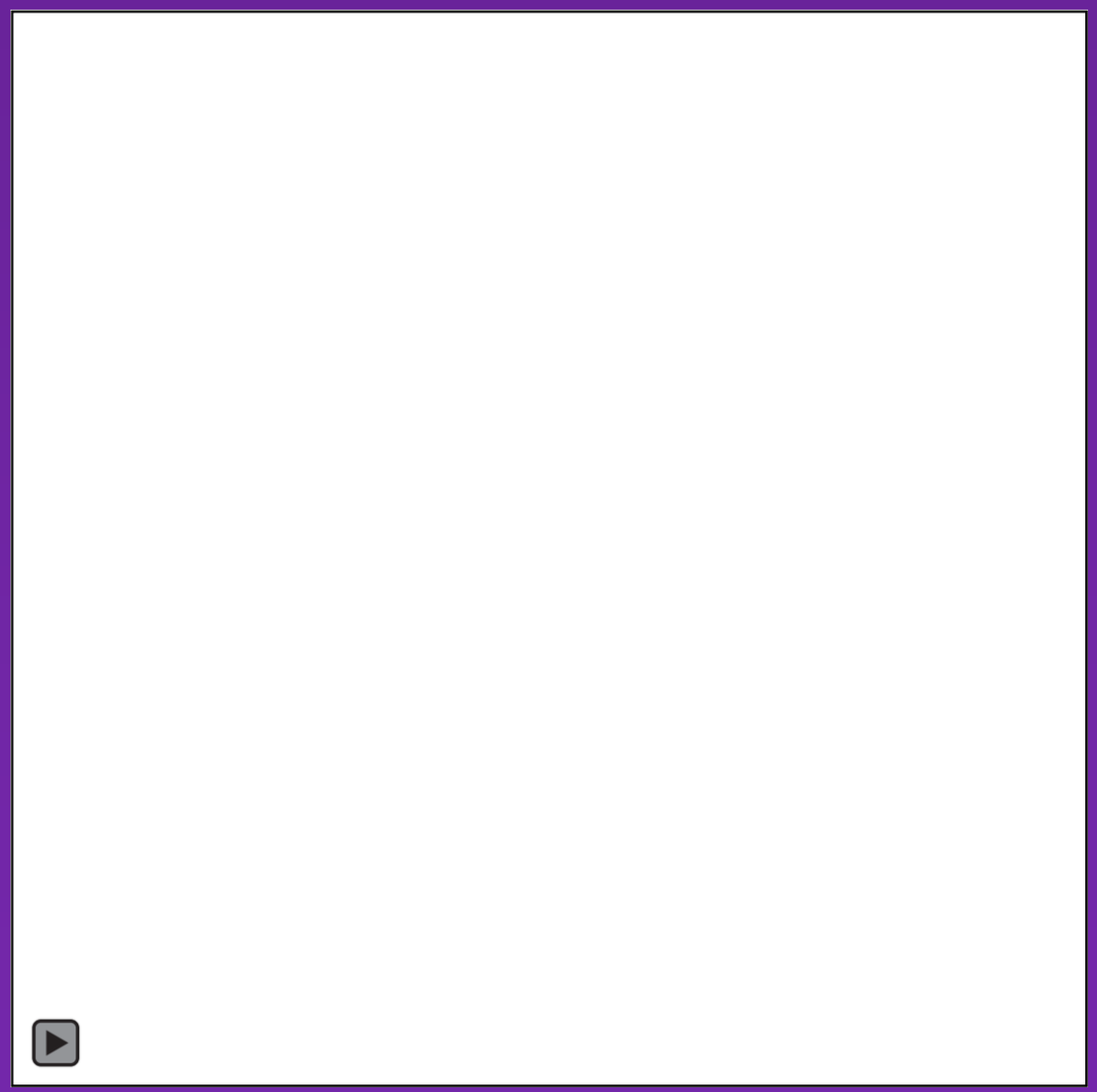
AR Jet Example 2: To investigate further, look at a different AR — Many violent jets:

- 14 Jan 2015 (NOAA AR 12259).
- AIA, HMI, Hinode, IRIS



Hinode/XRT



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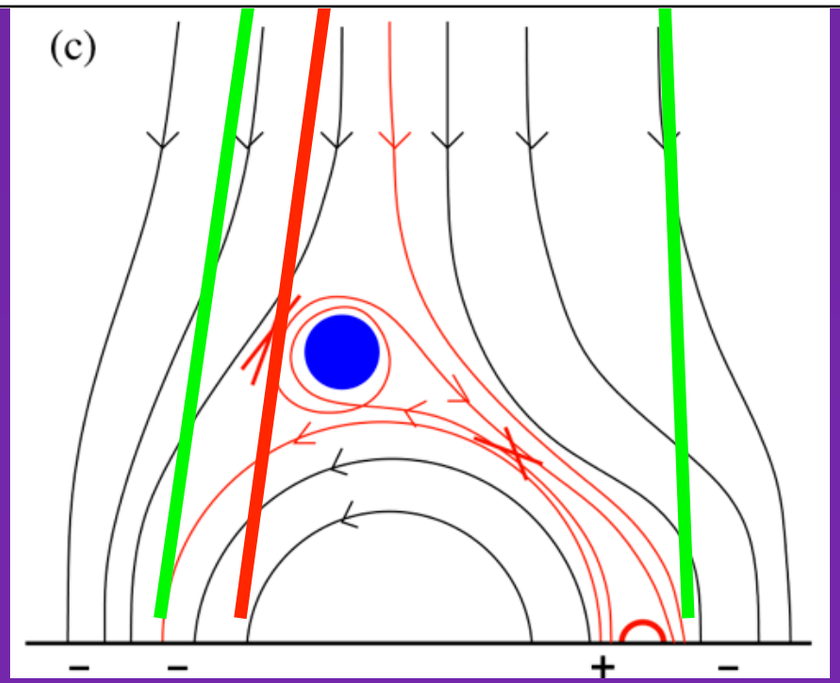
HMI on IRIS



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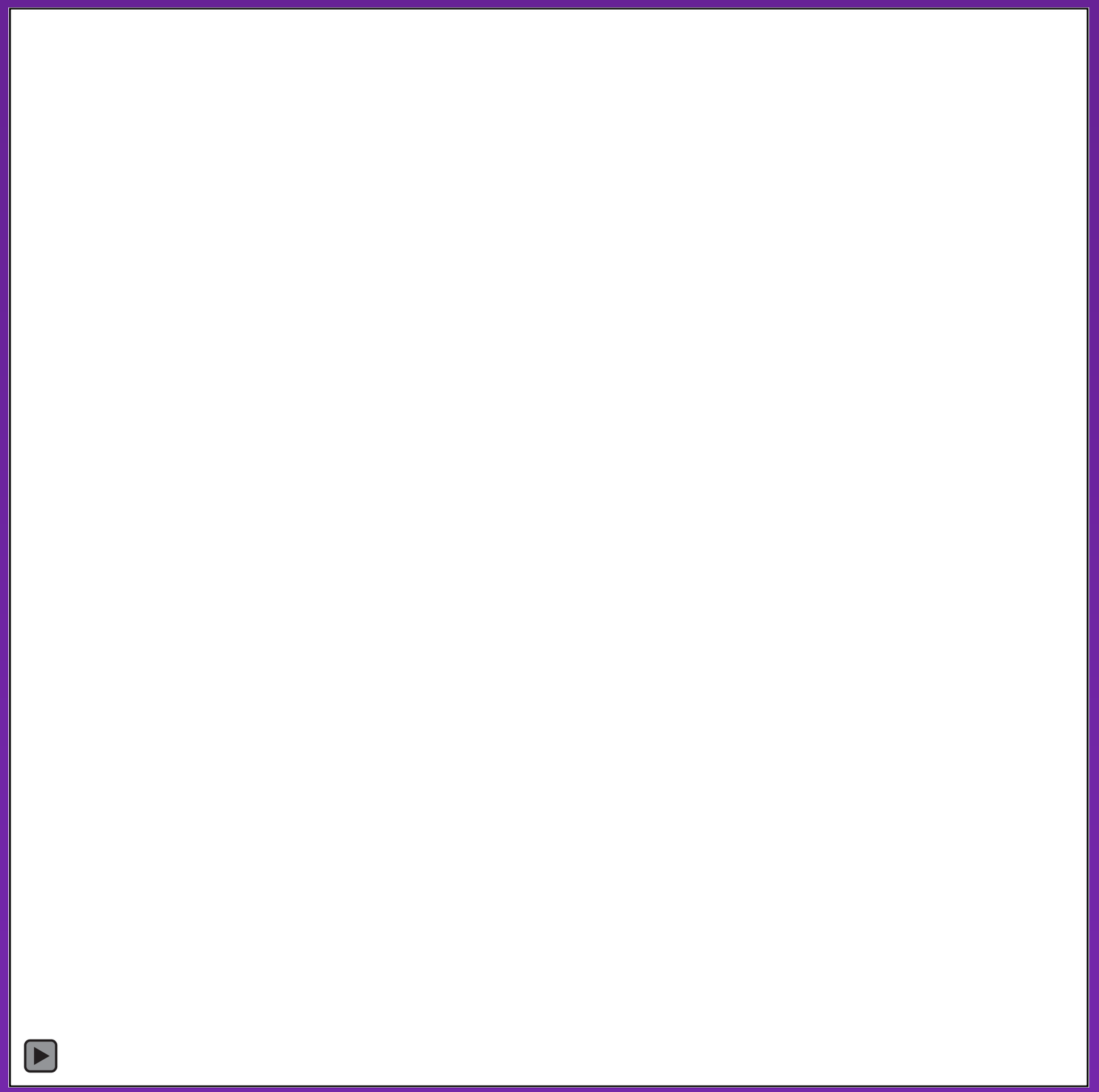
Is cool minifilament material hidden by a bright shell?



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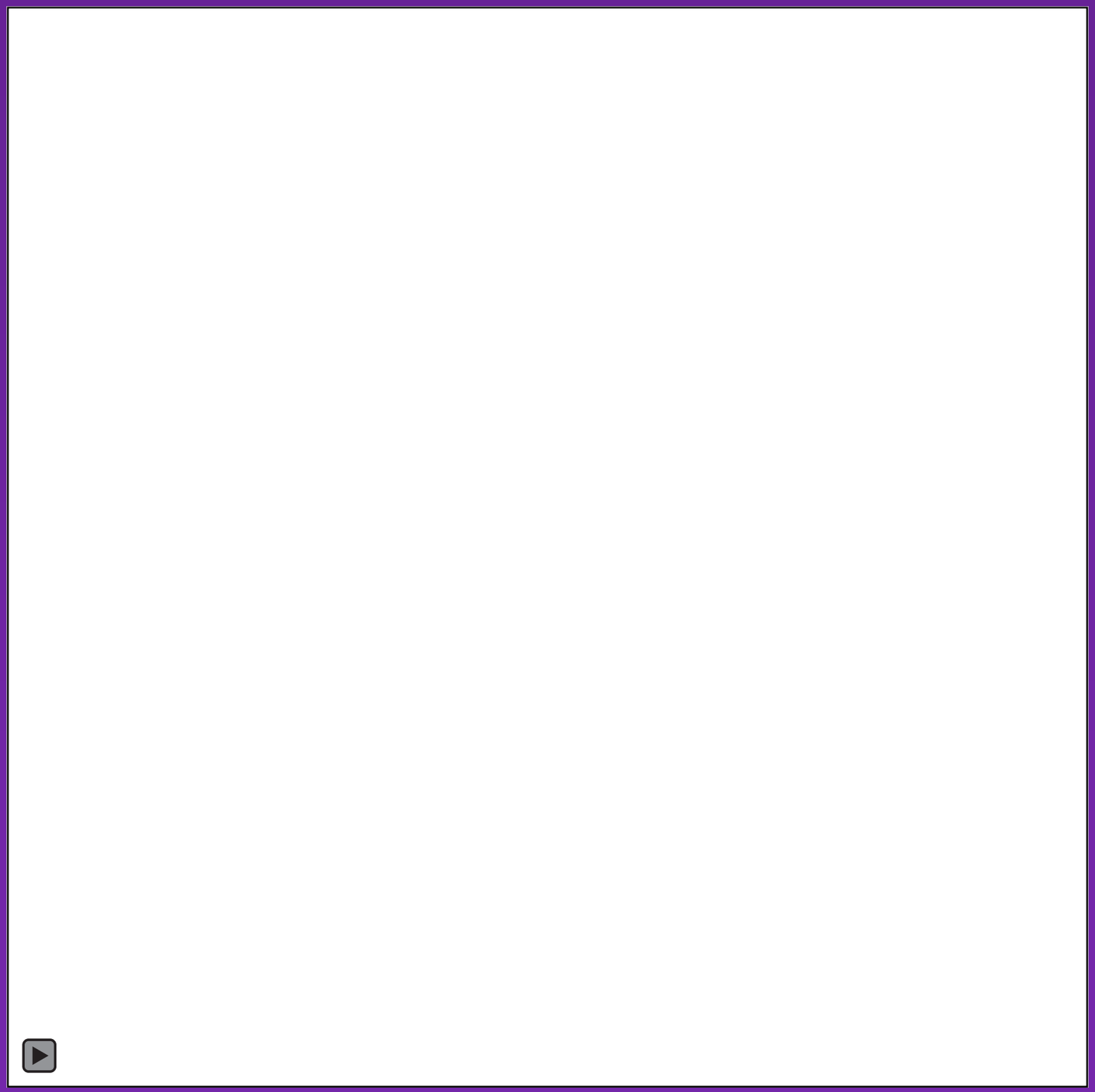
Bright filament “cocoons” envelope
some “normal” large-scale eruptions too:



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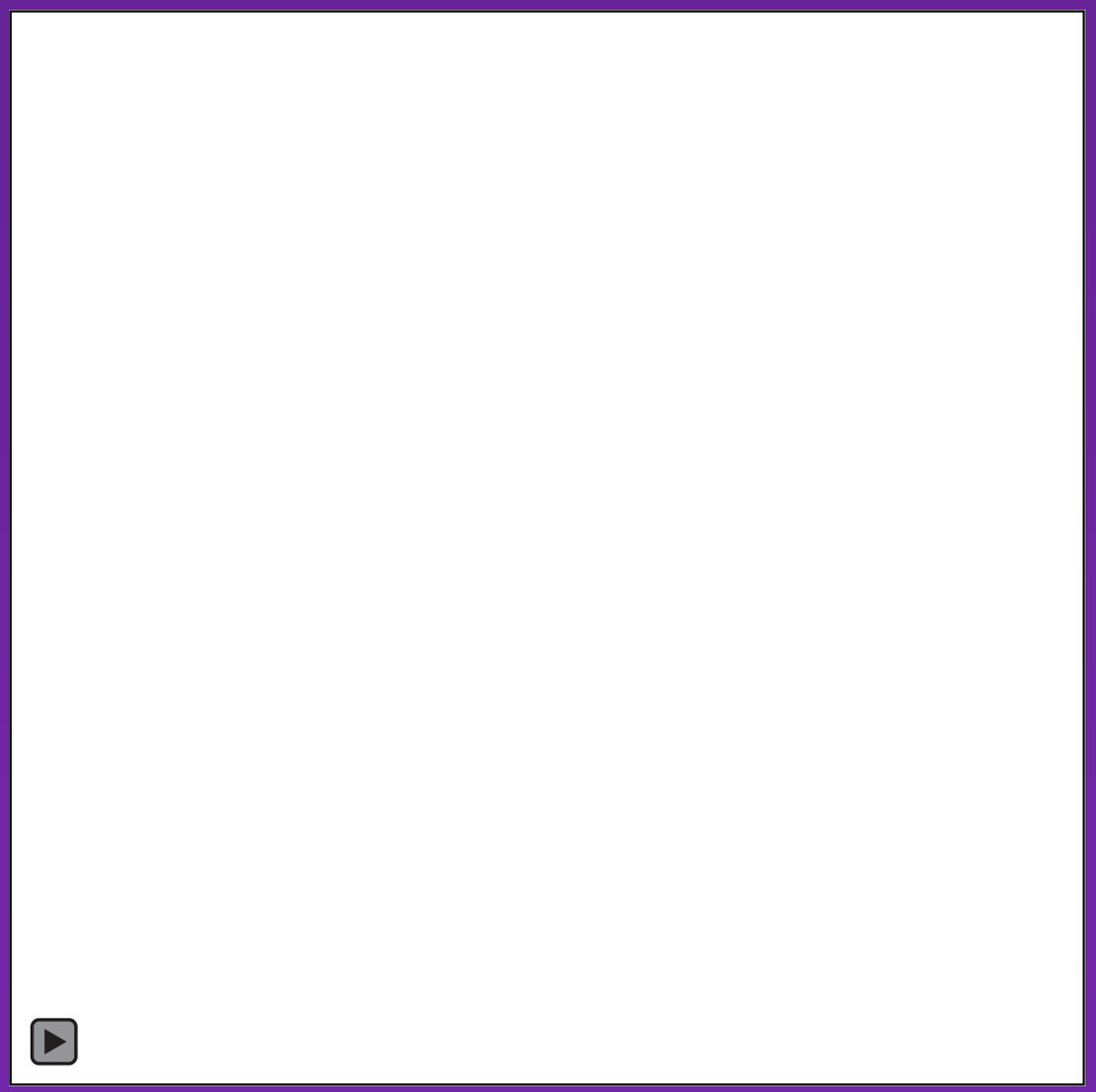
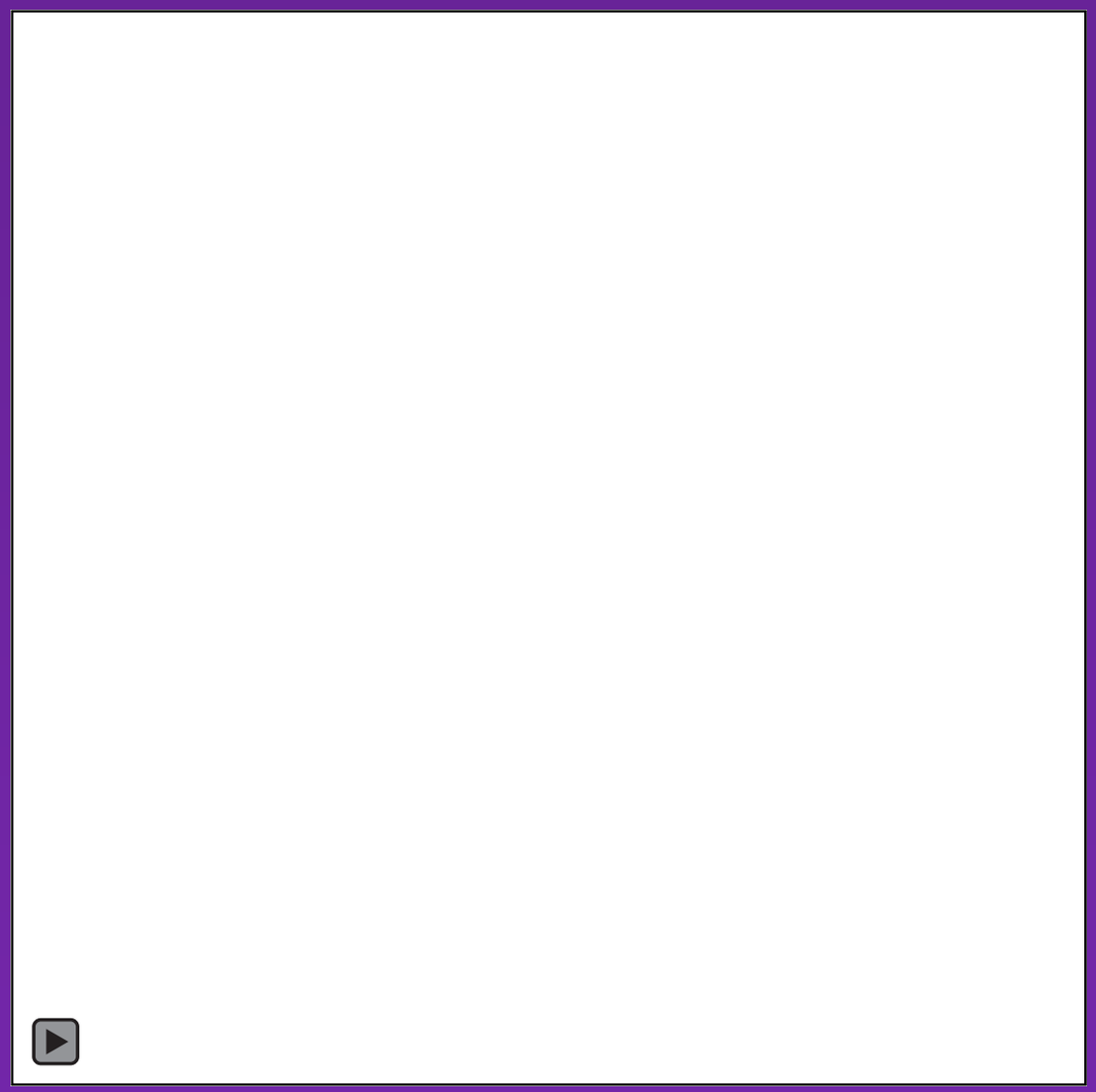
Consider neighboring jetting location:



Hinode/XRT



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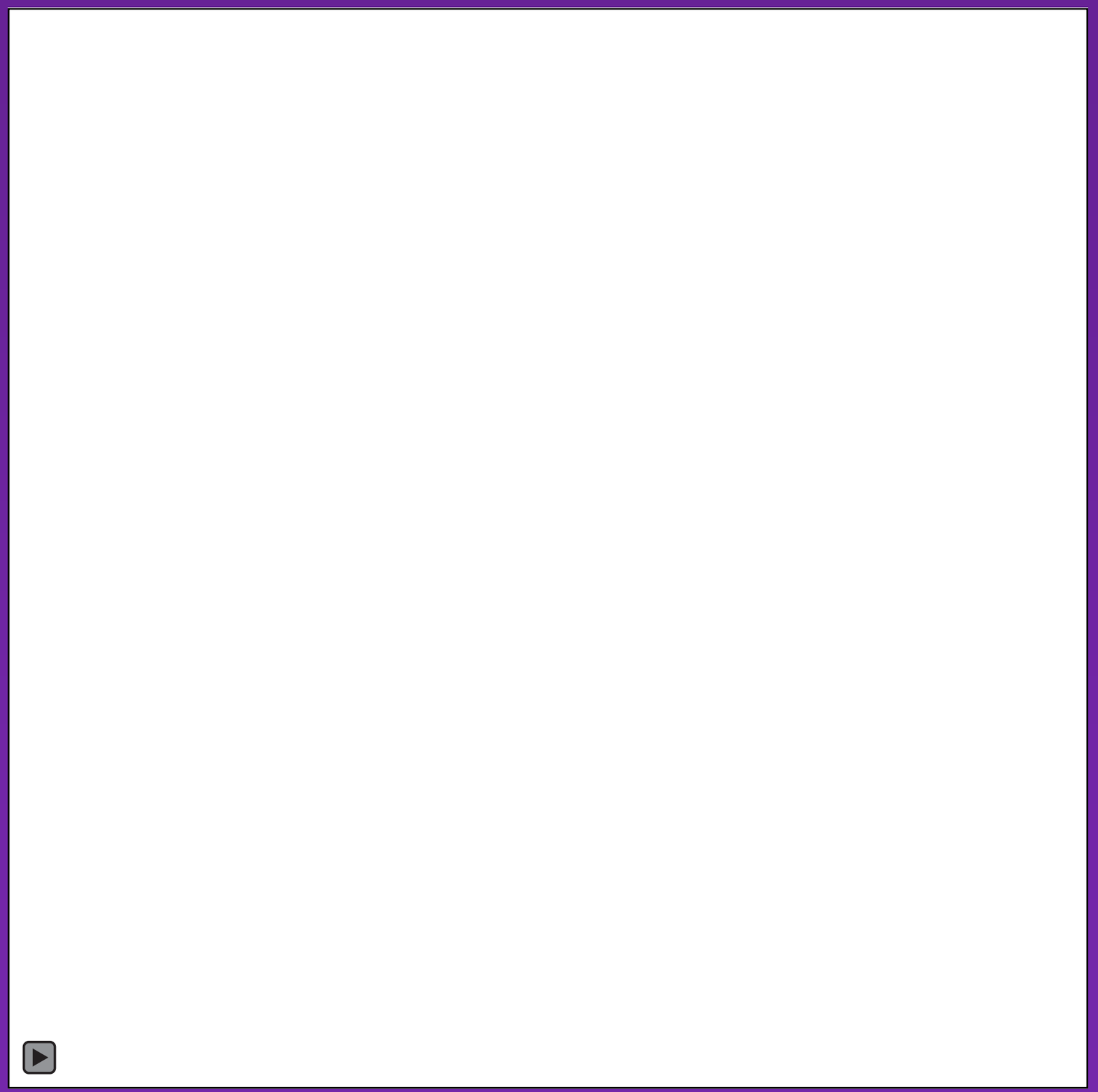
Minifilament “strand” visible from neighboring region, slightly different time.



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What triggers jet-producing minifilament eruptions?

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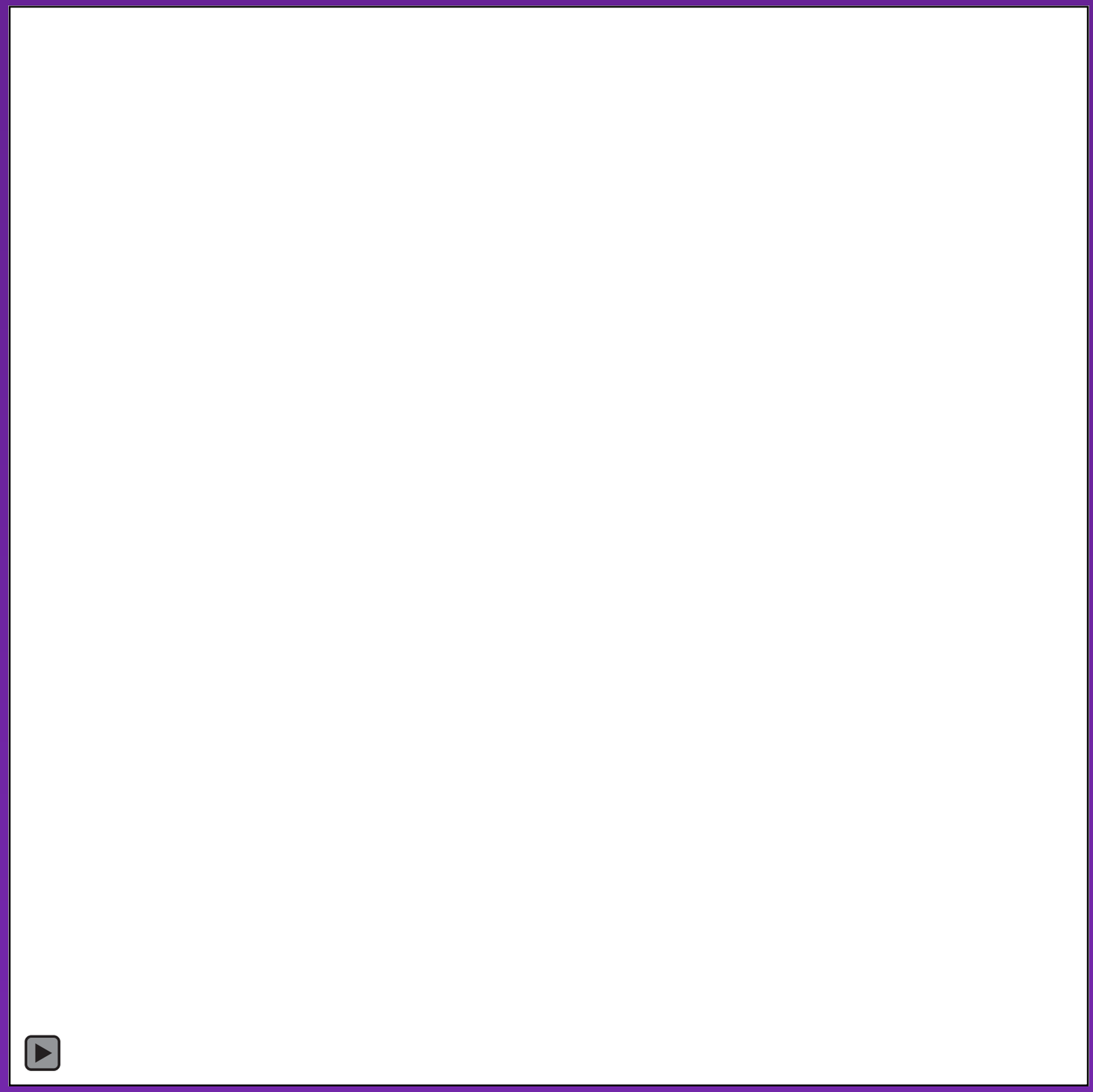
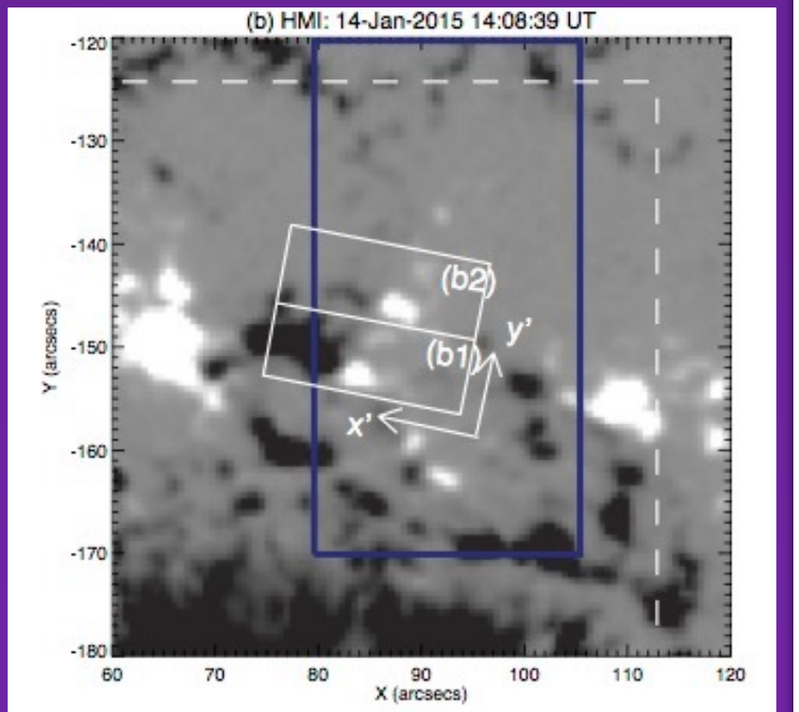
HMI of IRIS-observed region:

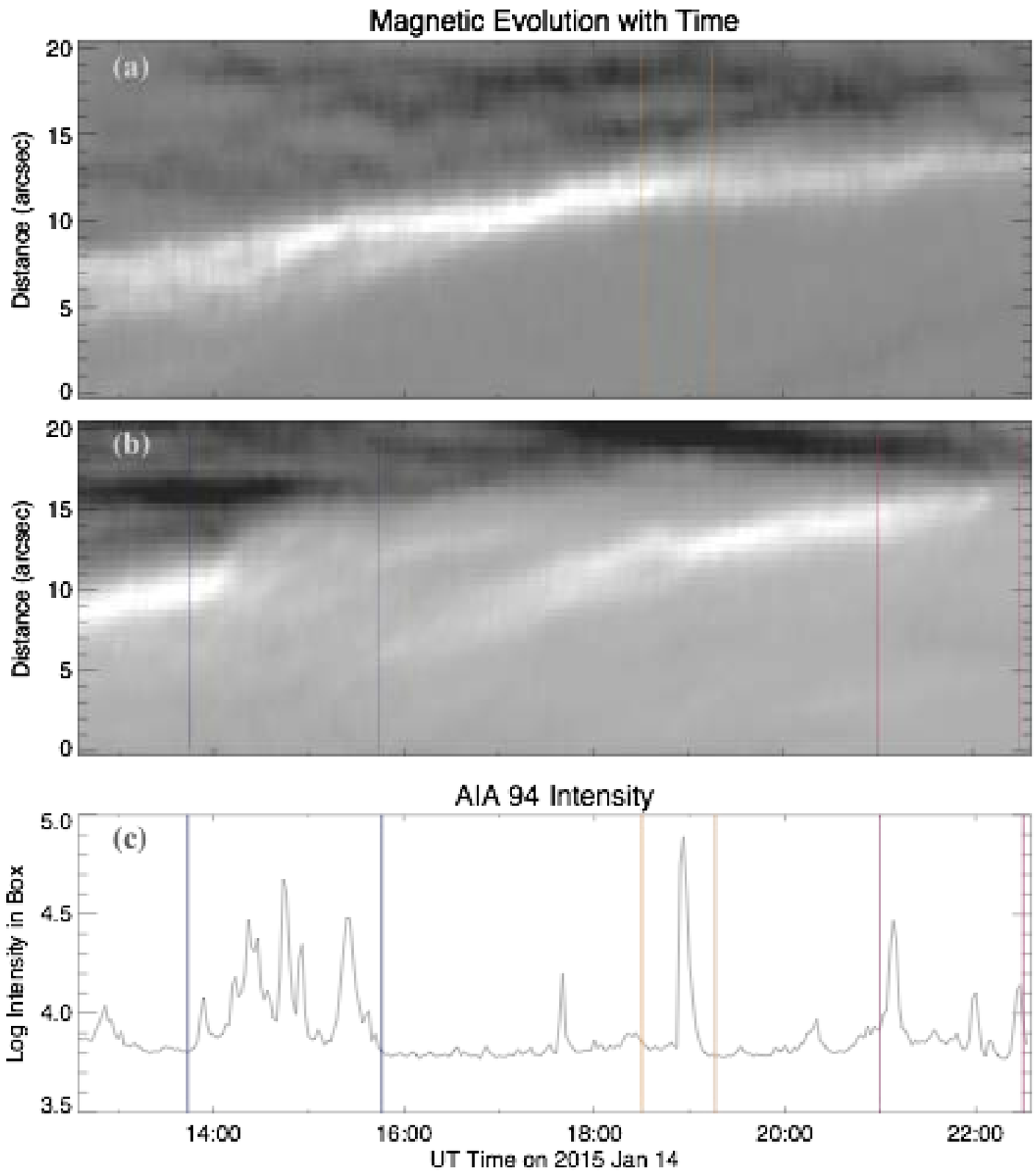


Jets occur at *flux cancelation* locations!

AR jets (Sterling et al. 2017)

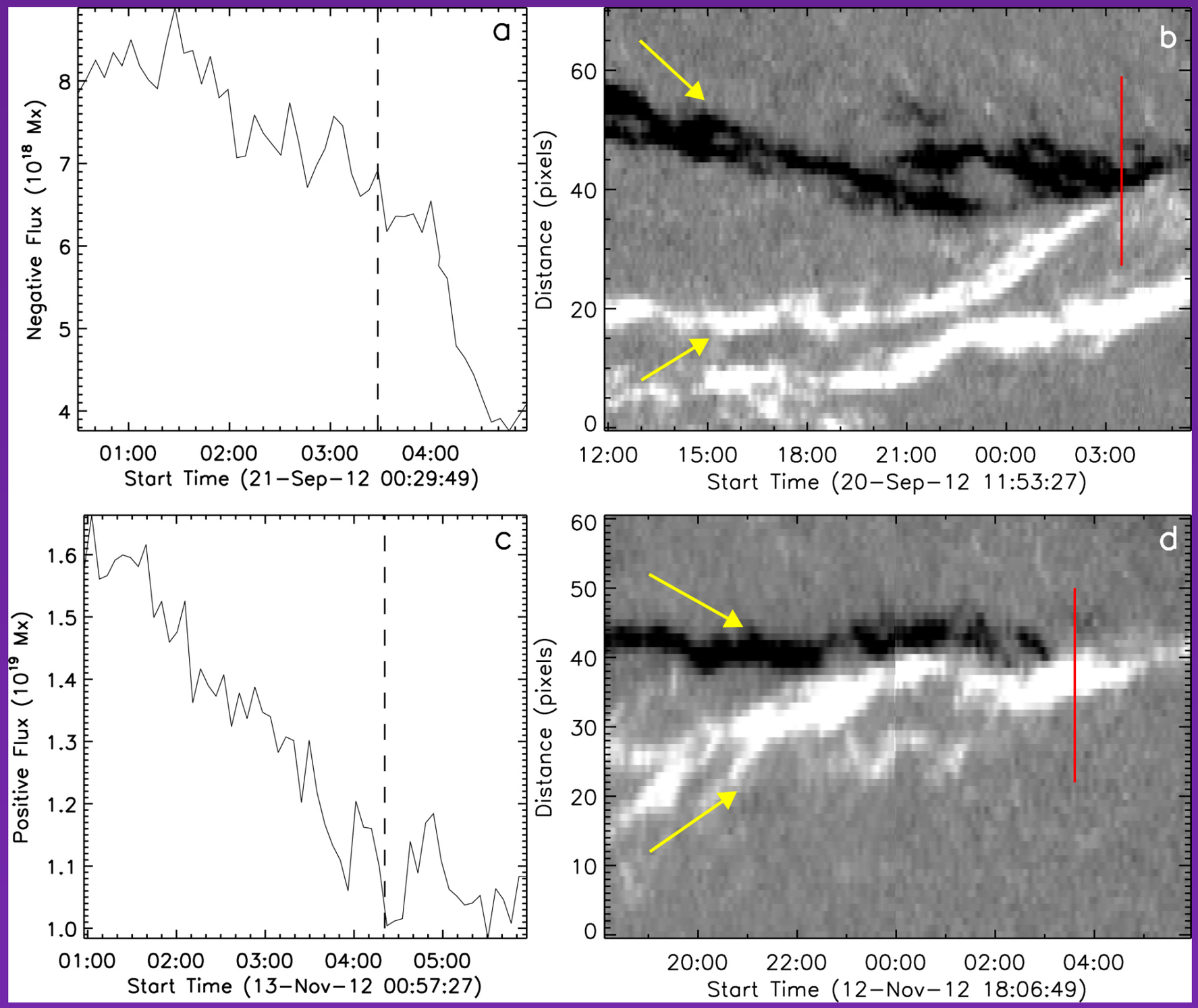


Ave. Cancelation rate: ~10^{19} Mx/hr.



Same for QS jets: Occur at cancelation sites.

Ave. Cancelation rate: ~10^{18} Mx/hr.



Panesar, Sterling, & Moore (2016) — 10 jets. (Poster!)

Summary, Discussion, and Conclusions

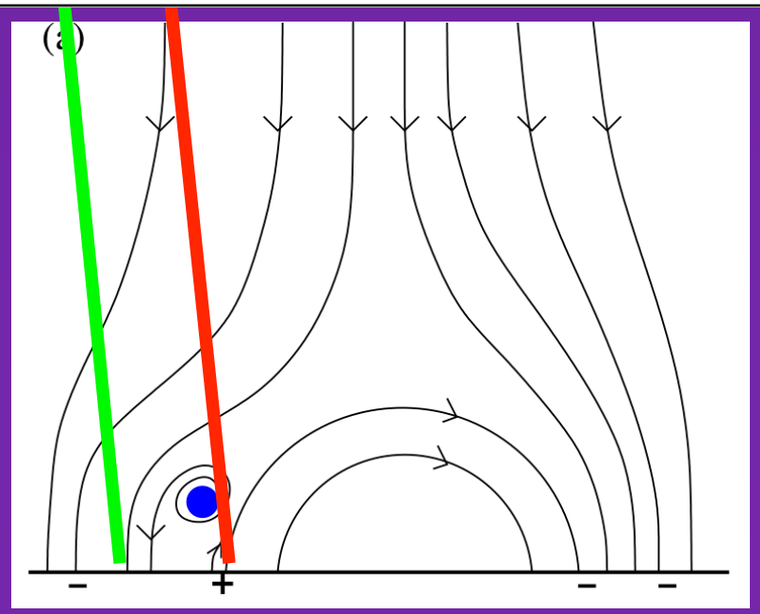
Detailed investigations of several jets (>20 CH; ~10 QS; ~10 AR):

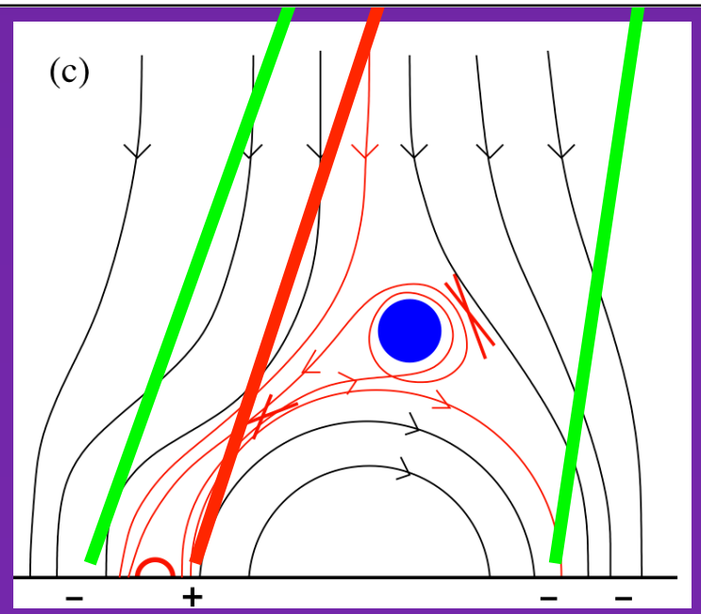
- All occur on neutral lines.
- Essentially all fit the minifilament-eruption picture (only one or two unclear ones).
- Some of the less-closely-inspected ones can be unclear, e.g. due to coronal “haze,” small size, or complex magnetic setting.

- Regarding AR jets:
- Slower-buildup ones have obvious erupting minifilaments.
- Faster-buildup ones may also have erupting minifilaments, but (1) they may be very thin ``strands,'' and hence hard to see; (2) cool minifilaments may be hidden by emission (cocoon and/or bright jet spire); (3) etc... (Sterling et al. 2017).

- AR and QS jets result from episodes of flux cancelation.

AIA 304





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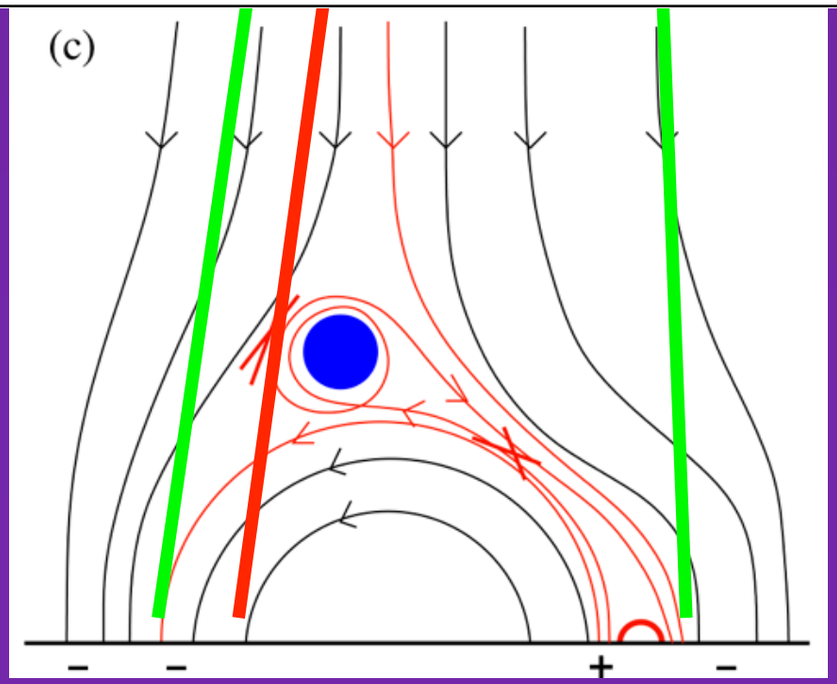
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Flux Cancelation Rates:

- For AR jets (~7 events): ~1.5 x 10^{19} Mx/hr (Sterling et al. 2017).

And from Panesar (2017, private comm.)

- For QS jets (~10 events): (1- 4) x 10^{18} Mx/hr.
- For CH jets (~10 events): (2 - 6) x 10^{18} Mx/hr.